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TO		INITIALS	DATE	REMARKS
DIR	4		12/12	<i>FyI only</i> This is applicable to NSAM-156 problem & our potential support of NASA & other civilian agencies in peaceful uses efforts. Received from [redacted]
DEP/DIR	3	<i>(initials)</i>		
EXEC/DIR	2	<i>CH</i>	12/12	
TECH ADV		<i>JWC</i>	12/12	
SPECIAL ASST	1	<i>M</i>	12/9	
ASST FOR P&M				
CH/SS				
ASST FOR OPS	5			
ASST FOR PA				
ASST FOR P&D				
CH/CSD				
CH/IPD				
CH/PD				
CH/PSD				
CH/TID				
CH/CIA/IAD				
CH/DIA/XX-4				
CH/DIA/AP-IP				
CH/SPAD				
LO/CGS/CIA				
LO/NSA				

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*Very interesting*  
*(Peaceful Uses*  
*file - O/Dir?)*

*PEACEFUL USES FILE*

ROUTING SLIP *logged*

TO	NAME AND ADDRESS	INITIALS	DATE
1.	NPIC [redacted]		
2.	[redacted]	<i>g</i>	
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RETURN TO SENDER			
ACTION		CONCURRENCE	INFORMATION
COMMENT		FILE	SIGNATURE

## REMARKS

Attached is a memorandum prepared by [redacted] as a result of his attendance at a recent unclassified meeting sponsored by the National Academy of Sciences. It has some interesting observations concerning possible future problems with NASA, etc.

C/COMOR

*Copy Sent to O/DIR - 8/12/66*

FROM

NAME AND ADDRESS	PHONE NO.
[redacted] 5B2830, Hqs	[redacted]
	DATE
	16 Nov 66

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14 November 1966

MEMORANDUM FOR: Chairman, Committee on Overhead Reconnaissance

SUBJECT: Briefing Note on the Potential Use of Remote Sensors for Studying and Recording Data on the Earth's Resources.

1. The following observations arise from my attendance at a two-day meeting (October 7 and 8, 1966) of the National Academy of Sciences - National Research Council (NAS/NRC) Committee Advisory to the U.S. Geological Survey's Geographic Applications Program. No classified information could be discussed and the following account is written in that vein.

2. [redacted] the two most significant aspects of the NASA Earth Resources Surveys Program (NERSP) and the associated U.S. Geological Survey's Space Applications Programs, in my judgment, are:

a. The expressed intent to use high-resolution cameras and other advanced sensors to observe the earth from orbiting space vehicles within the time period of roughly 1969-1972 [redacted]

[redacted] and

b. The expectation that the results of the orbital surveys of the earth will be made available to members of the United Nations. NASA's head of the NERSP is preparing a presentation to be given to the U.N. Committee of Space Research some time next year. (See memo from [redacted] OBI, of 2 November, 1966, forwarded to the DD/I, entitled

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"The NASA National Earth Resource Program. ")  
Two Latin American countries have already indicated an interest in the potential of the programs as described at a Pan American Institute meeting in Mexico City this summer.

Not to be overlooked, however, are the immeasurable benefits from the results of such surveys and scientific findings to our own military interests, to the economic and cultural planning of industrialized nations, and to the orderly development of the emerging, less-developed nations. Rapid coverage of extensive areas (many of which have previously been relatively inaccessible and unmapped), would provide a new dimension in area planning and development -- which would be greatly benefited, incidentally, if up-to-date map bases of large to small scale were available for use in portraying the distribution of the results of the surveys.

3. The high degree of interest in remote sensors among scientists and planners from educational institutions, government departments, and industry was evidenced by the large attendance at a series of Symposia on Remote Sensing of the Environment at Ann Arbor and arranged by the Institute of Science and Technology at the University of Michigan. The first Symposium was held in February 1962; the second in October 1962; the third in October 1964; and the fourth in April 1966. During this same period, the NAS/NRC Committee on Remote Sensing of the Environment was formed and is now promising to become quite active. A separate NAS/NRC Advisory Committee to the U. S. Geological Survey on the Space Program for Earth Observation was also established and presently has three subcommittees under it. One is the Advisory Committee for Geography noted in paragraph 1 of the memorandum; another is for geology/hydrology; and a third for oceanography. A fourth is under consideration for cartography (mapping), although this may be included with the Committee for Geography. Another separate NAS/NRC Advisory Committee on Remote Sensing exists for agriculture.

4. A variety of studies proposed by men (most of whom, to the best of my knowledge, have little or no clearance for handling classified information) working in the above fields have been sponsored by the Department of Interior [redacted] who does have clearances, is Research Coordinator for the Earth Orbiter Program

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for the U.S. Geological Survey), Agriculture, and the Navy, with funding provided by NASA's Office of Space Science and Applications (SAR) (see Tabs A and B). Proposals for additional feasibility studies are being actively sought. Many studies are under way, programmed, or under consideration. Test sites are chosen and so-called "ground truth" studies are undertaken at these sites. NASA normally provides the aircraft and sensors needed for responding to specified requirements formulated by the researchers (see Tabs C and D). A typical study is a proposal for a \$45,000 project submitted by the Kansas University to determine the utility of radar and other remote imagery for thematic land use mapping. Under a contract with the University of California (Riverside/UCLA) test sites have been established in the Southern California/Salton Sea area for defining the scientific and economic benefits of remote sensing as a means for examining the resources of a region and for developing skilled scientists in using imagery and other data from the sensors. Another proposal from Northwestern University has been submitted for examining the potential of remote sensing from orbital spacecraft as a data source for urban and transportation analyses. Test sites suggested are Phoenix and Chicago.

5. The NASA funding for the Geographic Applications Program, conducted as part of the U.S. Geological Survey's program, was nearly \$615,000 for the period from May 1966 to the end of January 1967. To date \$276,000 have been obligated, of which \$100,000 are for overhead, staff, travel, and committee expenditures. Funds can be carried over. The current contract with Northwestern University amounts to roughly \$50,000 and that with the University of California, \$64,000. Additional NASA funding is expected as the program advances. I do not have data on funding in the other disciplinary fields, but I am sure it is substantially greater because studies in those areas are more advanced.

6. Gemini photography, at least some of which was taken by hand-held Hasselblad cameras (with 250 mm focal length lenses and 70 mm interchangeable color and black/white film packs), produced startlingly clear imagery and dramatic color contrast, as you know. The viewing of this photography has whetted the appetites of men who have been interested in exploring the effectiveness of various sensors for obtaining data required for analyzing a host of problems relating to physical and cultural resources (see Tab E).

Geodesists at Ohio State University are devising a coordinate grid system to make Gemini photography more useful for broad interpretation. A mosaic of northern South America will be made from Gemini photography.

7. A representative of the OAS noted the tremendous lack of data on Latin America and the interest of OAS in coverage by remote sensing. (As an illustration of what is needed, he exhibited a group of maps printed at 1:250,000 scale, based on AMS photomaps of 1:60,000 scale constructed from aircraft photography. These materials were subjected to analysis by 30 photo interpreters. The final maps are excellent portrayals of the distribution of hydrology, transportation, rainfall, soils, land capability, land use, geology, and population distribution for Santo Domingo. The magnitude of the effort for this small country must have been very great, considering the conventional means that had to be used.)

8. At the October meeting for the Advisory Committee of Geographic Applications, information was provided by NASA representatives regarding the possible inclusion of several sensors in the Apollo and possible other oncoming NASA vehicles. The potentials excited those present and they are looking forward to great improvements in image resolution and in other data from orbiting sensors (see Tab F -- AAP refers to Apollo Applications Program and ERS to the EROS concept). It was stated that the Apollo vehicles might reach 50 degrees north and south latitude. It was further recognized that many of the proposed sensors for inclusion are only in the R&D stage. Any sensors, if installed, would be greatly subordinated to the main objectives of the Apollo missions, at least until primary Apollo objectives are totally achieved. Also for future inclusion, 24" panoramic cameras with 74 degree scan associated with 12" frame cameras were discussed (see Tab G).

9. There was some discussion of direct dollar benefits that might be realized from use of remote sensor data. It was pointed out that, for 1:250,000 scale mapping of the United States alone, 130,000 stereo-photo models would be needed if obtained from aircraft coverage and only 1,200 such models would be required if obtained from orbiting satellites. Annual savings in maintaining the U.S. Geological Survey's 1:24,000 map series of the U.S. by use of orbital photography would amount to \$2,000,000, and the annual benefit to user groups in the many

sectors of the U.S. economy which depend on such maps would approximate \$136,000,000 at the present time. It was felt that orbital stereo photography for mapping could save three to five years time in up-to-date map maintenance and production for U.S. coverage.

10. Concern was expressed over the magnitude of the task for processing, storing, and retrieving the information to be obtained from the orbiting sensors. It was recognized that automation must play a larger role in the handling and analysis of the data and that all possible assistance should be sought from government agencies now facing similar problems in information processing and maintenance of data banks.

11. Obviously there is some wishful and naive thinking and vaguely formulated planning inherent in the discussions at the two-day meeting I attended as an observer. It seems essential that those officials involved in managing overhead reconnaissance do whatever they can to guide and cooperate with those responsible for the Earth Resources Programs in order that unnecessary duplication in hardware design and development is avoided, and that maximum use of data from orbital sensors (admittedly involving appropriate sanitization and declassification) can be ensured in fulfilling the important objectives of earth resource surveys for military, economic, and political purposes. Future configurations of earth orbiting vehicles may be able to fulfill efficiently (with proper safeguards for the handling of sensitive material) a greatly broadened, all-inclusive set of requirements for earth observation from space -- both for intelligence and for all other users dependent upon improved knowledge of their countries' resources.



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NASA'S EARTH RESOURCES SURVEY PROGRAMS WITH OTHER AGENCIES IN  
AGRICULTURE, FORESTRY, GEOGRAPHY, GEOLOGY, HYDROLOGY, AND OCEANOGRAPHY

OUTLINE OF SOME OF THE FUNCTIONS OF THE DEPTS. OF AGRICULTURE, INTERIOR AND NAVY:

1. DEFINE THE OBJECTIVES OF EACH DISCIPLINE FOR THE FEASIBILITY, SPACEFLIGHT TESTING, AND OPERATIONAL PHASES OF NASA'S EARTH RESOURCES SURVEY PROGRAM
2. ESTABLISH THE FEASIBILITY OF COLLECTING USEFUL EARTH RESOURCES DATA FROM SPACECRAFT
3. STUDY AND DOCUMENT THE ECONOMIC JUSTIFICATION FOR EARTH RESOURCES SURVEYING AND DATA COLLECTION FROM SPACE
4. ESTABLISH INSTRUMENT REQUIREMENTS AND SPECIFICATIONS FOR EARTH RESOURCES SURVEYING FROM SPACE
5. DOCUMENT THE DATA ACQUISITION PRIORITIES AND REQUIREMENTS (AREAL COVERAGE, TIMING, FREQUENCY OF COVERAGE) FOR EARTH RESOURCES SURVEYS DURING AIRCRAFT, SPACEFLIGHT TESTING AND OPERATIONAL PHASES
6. PERIODICALLY DOCUMENT SCIENTIFIC ACHIEVEMENTS MADE BY EACH DISCIPLINE DURING THE AIR AND SPACEBORNE PHASES OF THE PROGRAM
7. DEVELOP METHODS FOR UTILIZING EARTH RESOURCES DATA COLLECTED FROM SPACE

NASA SA66-15795  
7-26-66

## EARTH RESOURCES SURVEY PROGRAM

### OBJECTIVES

1. TO DETERMINE THOSE NATURAL AND CULTURAL RESOURCE PHENOMENA WHICH CAN BE BEST ACQUIRED FROM SPACE FOR THE ECONOMIC BENEFIT OF THE NATION AND MANKIND.
2. TO DEVELOP THE BEST COMBINATION OF SPACE FLIGHT INSTRUMENTS, SUB-SYSTEMS, OBSERVATIONAL PROCEDURES, AND INTERPRETATIONAL TECHNIQUES FOR GATHERING NATURAL AND CULTURAL RESOURCE DATA AND TO TEST THESE WITH AN EVOLUTIONARY SERIES OF EXPERIMENTAL MANNED AND UNMANNED SPACECRAFT.

### APPLICATIONS

#### AGRICULTURE AND FORESTRY PRODUCTION

GATHER DATA ON PLANT VIGOR AND DISEASE IN ORDER TO AID IN THE INCREASE OF AGRICULTURE AND FOREST PRODUCTION.

#### GEOGRAPHY, CARTOGRAPHY, CULTURAL RESOURCES

GATHER DATA TO PERMIT BETTER USE OF RURAL AND METROPOLITAN LAND AREAS AND TO UPDATE TOPOGRAPHIC BASE MAPS AND CENSUS INVENTORIES.

#### GEOLOGY AND MINERAL RESOURCES

GATHER DATA TO AID IN 1) THE DISCOVERY AND EXPLOITATION OF MINERAL AND PETROLEUM RESOURCES; 2) THE PREDICTION OF NATURAL DISASTERS.

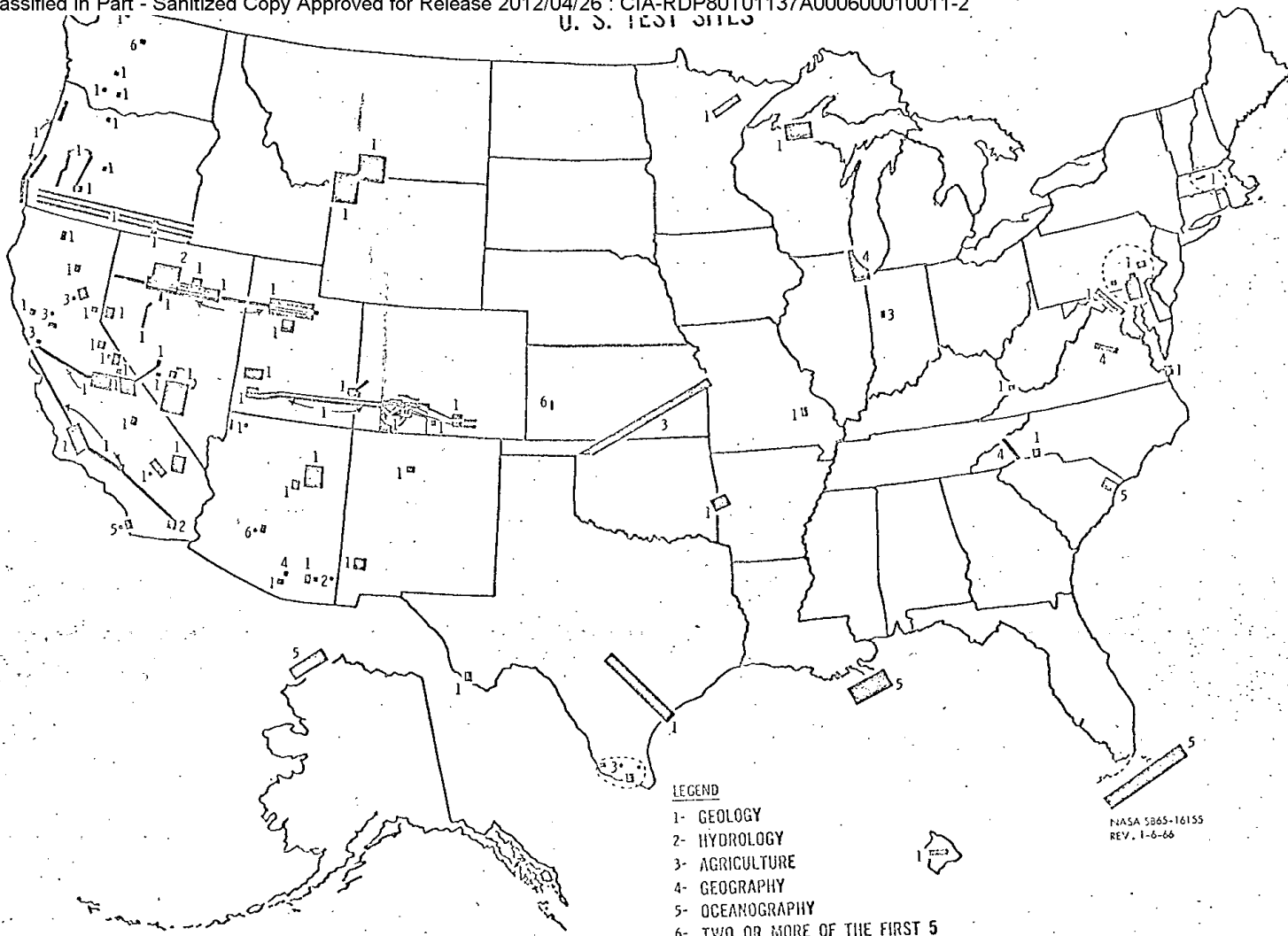
#### HYDROLOGY AND WATER RESOURCES

GATHER DATA TO AID IN THE LOCATION AND BETTER USAGE OF WATER RESOURCES.

#### OCEANOGRAPHY AND MARINE RESOURCES

GATHER DATA TO AID IN OCEAN TRANSPORTATION AND TO AID IN BETTER UTILIZATION OF FISHERIES.

NASA HQ SA67-15106  
10-5-66



- LEGEND
- 1- GEOLOGY
  - 2- HYDROLOGY
  - 3- AGRICULTURE
  - 4- GEOGRAPHY
  - 5- OCEANOGRAPHY
  - 6- TWO OR MORE OF THE FIRST 5
- \* FUNDAMENTAL SITES

NASA SB65-16155  
REV. 1-6-66

# NASA EARTH RESOURCES SURVEY AIRCRAFT CONVAIR 240-A SHOWING INSTRUMENT LOCATIONS

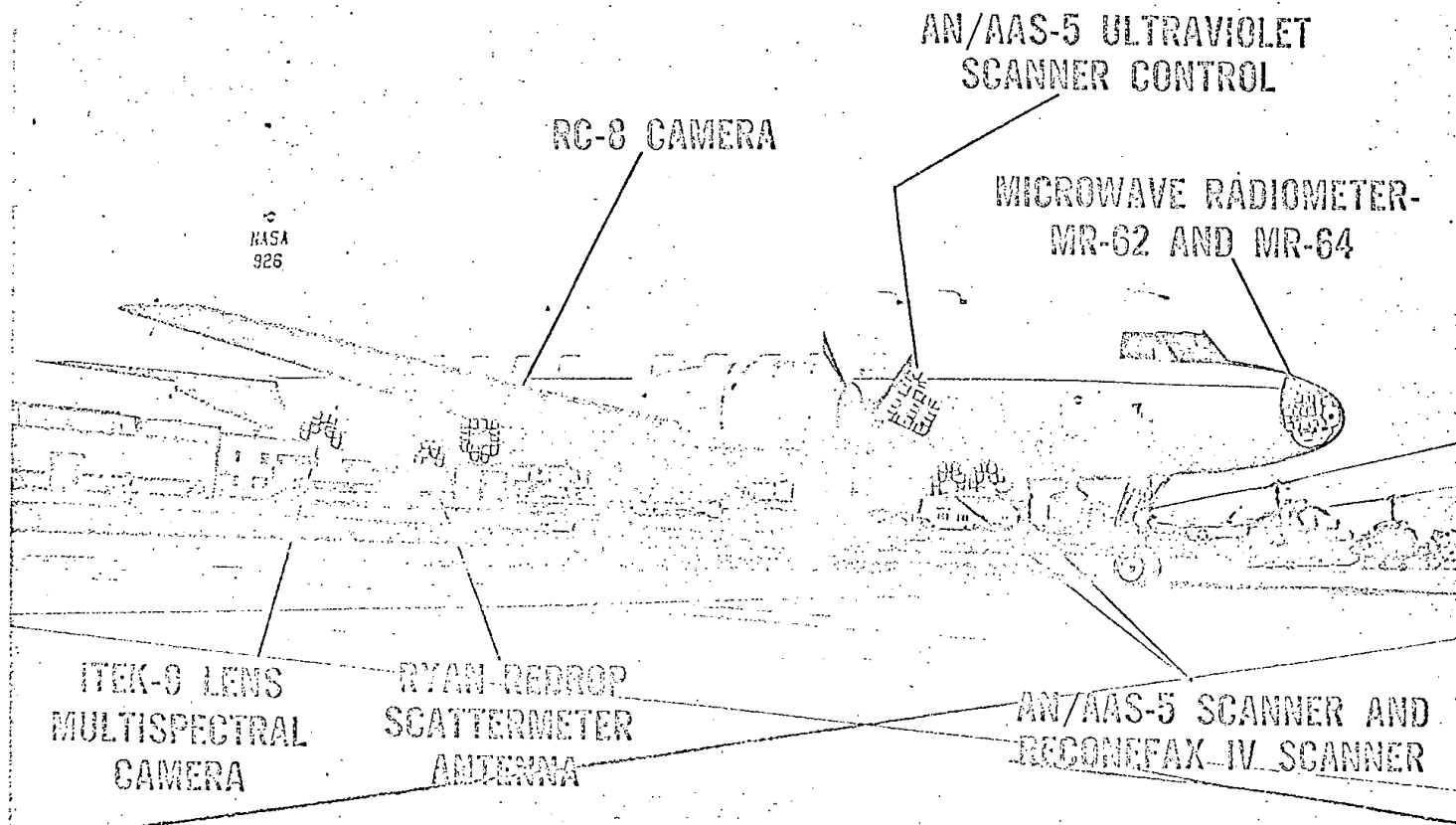


TABLE I

ANTICIPATED APPLICATIONS OF  
EARTH RESOURCES DATA  
GATHERING SYSTEMS

	VEGETATION DENSITY	GRASS-BRUSH-TIMBERLAND INTERFACES	PLANT SPECIES AND VIGOR	SOIL TYPES AND MOISTURE	IRRIGATION TEMP. & MOISTURE	FIRE DETECTION	LAND USE	TRANSPORTATION & INFRASTRUCTURE	SETTLEMENT & POPULATION	RESOURCES UTILIZATION	CLIMATIC CONDITIONS	TOPO. MAPPING	COMPOSITION & GEOMORPHOLOGY	STRUCTURE	MINERAL DEPOSITS	ENGINEERING	CRUSTAL DEFORMATION	EVAPOTRANSPIRATION	RAIN DISTRIBUTION	GROUND WATER STUDIES	WATER POLLUTION & INFILTRATION	SNOW SURVEILLANCE	EFFLUENTS OF MAJOR RIVERS	THERMAL CONDITIONS	SEA SURFACE ROUGHNESS	STORMS & COASTAL HAZARDS	BIOLOGICAL PHENOMENA	ICE SURVEILLANCE	SUBSURFACE STRUCTURE
METRIC CAMERA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PANORAMIC CAMERA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MULTISPECTRAL TRACKING TELESCOPE	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MULTIBAND SYNOPTIC CAMERA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RADAR IMAGER	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RADAR ALTIMETER/SCATTEROMETER																													
WIDE RANGE SPECTRAL SCANNER*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
IR RADIOMETER/SPECTROMETER	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MICROWAVE IMAGER				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MICROWAVE RADIOMETER				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LASER ALTIMETER/SCATTEROMETER																													
MAGNETOMETER																													
GRAVITY GRADIOMETER																													
ABSORPTION SPECTROSCOPY																													
RADIO FREQUENCY REFLECTIVITY																													
VIEWFINDER **																													
ULTRAVIOLET SPECTROMETER-IMAGER																													
EARTH BASED SENSORS***																													

\* 0.32 - 14.0 microns

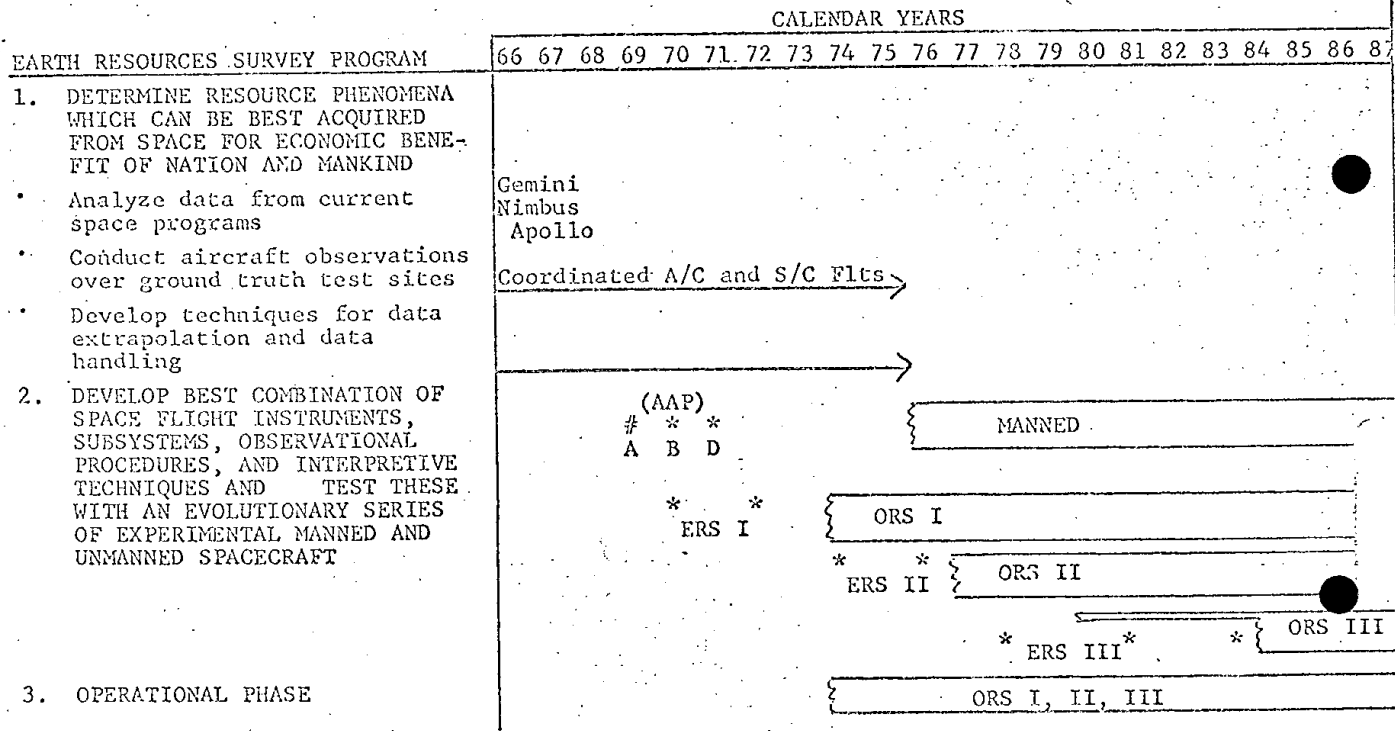
\*\* This instrument augments an astronaut's vision with optical power and directional data. The astronaut can utilize the viewfinder by itself or in conjunction with other directional type sensors.

\*\*\* These earth-based sensors may include a number of fixed and mobile instruments, such as buoys, seismographs, stream gauges, and so forth, placed on or near the earth's surface for detecting, recording, and transmitting a variety of earth resources phenomena of interest to a large number of users.

This table has been summarized from more detailed tables for each discipline and therefore does not include all the anticipated applications which have been identified to date.

NASA SA-66-15248  
REV. 7-29-66

MILESTONE CHART

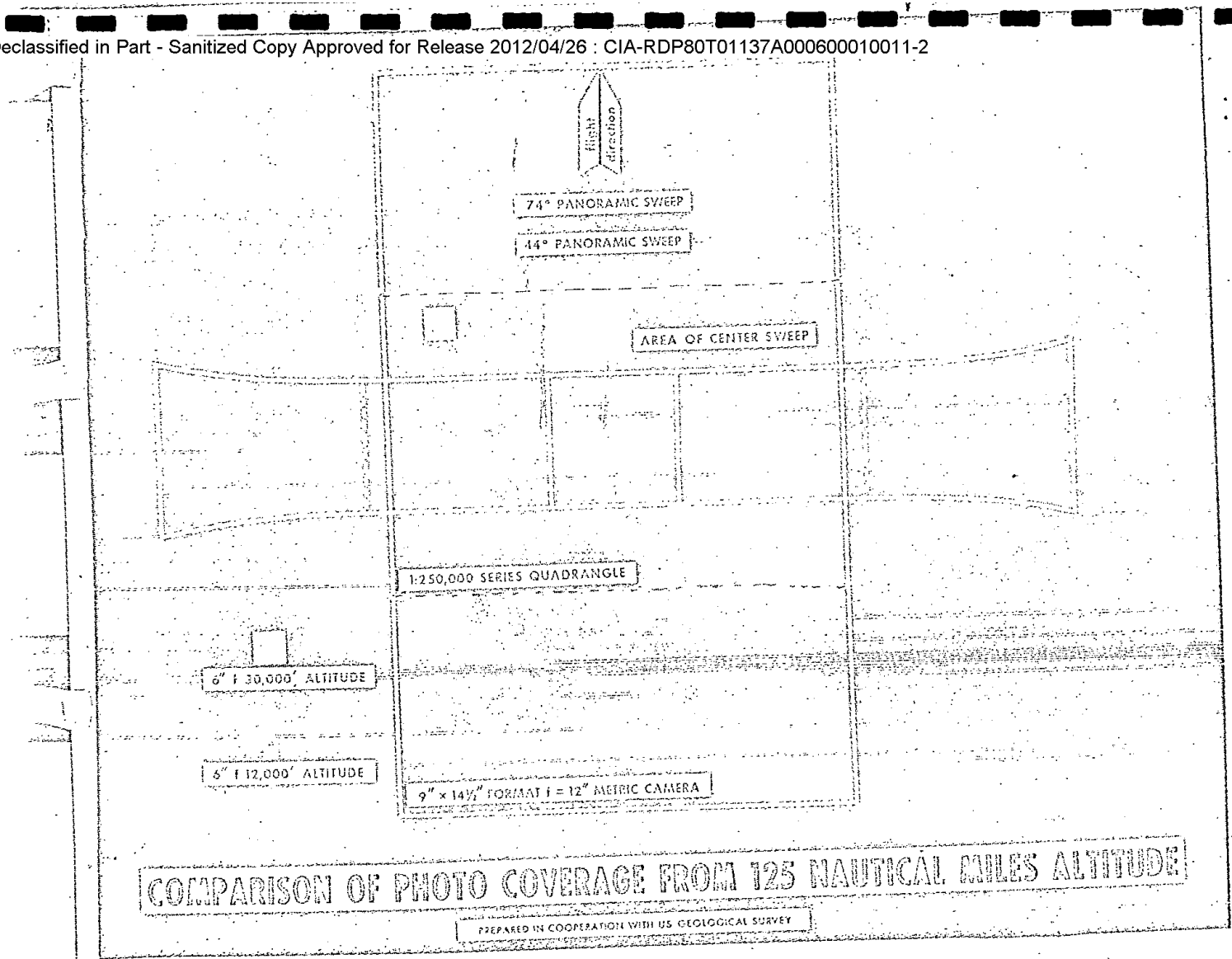


# = PLANNED; \* = PROPOSED  
ERS = Earth Resources Satellite  
ORS = Operational Resources Satellite

NASA HQ SA67-15162 10/16/66

SAMPLES OF REQUIREMENTS IN TERMS OF RESOLUTION RANGES	ASSOCIATED MAPPING LIMITATIONS		INSTRUMENTS AVAILABLE TO COLLECT DATA FROM 200 NM		AVAILABILITY AND TIMING OF SPACECRAFT TO MEET REQUIREMENTS	
	PRODUCTION	REVISION	INSTRUMENT TYPE	RESOLUTION	SPACECRAFT	YEAR
LESS THAN 20 METERS: CROP & TIMBER SPECIES BUILDINGS, STREETS, ETC. DETAILED CENSUS SMALL FAULTS, AND FRACTURES LOCAL WATER LEVELS, POLLUTION AND SEDIMENTATION SPECIFIC SEA STATE	1:100,000	1:20,000	95" TRACKING TELESCOPE 24" PANORAMIC CONVERGENT CAMERAS 12" METRIC CAMERA SYSTEM	2-3 METERS 6-15 METERS 18-30 METERS	AAP-B, D MAN FOLLOW-ON ERS-III ORS-III	1970-71 POST '72 1978 1985
20 TO 100 METERS: CROP AND FOREST TYPES URBANIZATION & LAND USE SYNOPTIC CENSUS GENERAL GEOLOGIC ANALYSIS WATER SNOW AND ICE INVENTORY GROSS SEA STATE	1:250,000 (LIMITED CULTURE)	1:100,000 (LIMITED CULTURE)	12" METRIC CAMERA SYSTEM 6" MULTIBAND SYNOPTIC CAMERA SYSTEM SIDE-LOOKING RADAR ADVANCED TV* SYSTEM	18-30 METERS 30-50 METERS 20-40 METERS 30-100 METERS		
100 TO 300 METERS: PRIMARY LAND USE (FORESTRY, AGRICULTURE, BARREN) REGIONAL GEOLOGY WATER, SNOW, AND ICE LINES	1:1,000,000 (LESS CULTURE)	1:250,000 (LESS CULTURE)	3" HASSELBALD & MAURER CAMERAS 35mm OR 70mm DIELECTRIC TAPE CAMERA NIMBUS TYPE TV MULTISPECTRAL SCANNER	100-200 METERS 100-200 METERS 200-400 METERS 200-300 METERS	GEMINI NIMBUS APOLLO ERS-I ORS-I	1966 1966 1967 1970 1974

NOTE: AN ADVANCED TV SYSTEM WITH 30-100 METERS RESOLUTION MAY BE AVAILABLE FOR SPACE USE BY 1970.  
THE ERS-I AND ORS-I SPACECRAFT COULD NOT HANDLE THE FILM TYPE CAMERAS OR SIDE LOOKING IMAGING RADAR.



COMPARISON OF PHOTO COVERAGE FROM 125 NAUTICAL MILE ALTITUDE

THE ILLUSTRATION COMPARES GROUND COVERAGE AFFORDED BY A 24-INCH FOCAL LENGTH, 12 DEGREE LENS CONE PANORAMIC CAMERA EXPOSURE, WITH A 12-INCH FOCAL LENGTH, 72 DEGREE LENS CONE FRAME CAMERA EXPOSURE. THEIR FORMAT COVERAGE IS SHOWN PLOTTED ON THE OUTLINE OF AN AVERAGE 1:250,000 SCALE (1 INCH = 4 MILES) MAP.

FOR FURTHER COMPARISON A BLOCK SYMBOL IS USED TO ILLUSTRATE GROUND COVERAGE AFFORDED BY 6-INCH FOCAL LENGTH, 90 DEGREE LENS CONE, FRAME CAMERA PHOTOGRAPHY FROM 30,000- AND 12,000-FOOT ALTITUDES. SUCH PHOTOGRAPHY FLOWN AT 30,000-FOOT ALTITUDE WAS NORMALLY USED TO COMPILE THE 1:250,000 SCALE MAP SERIES OF THE UNITED STATES.